

Merits of the Invention

The alkaline cell separator pertaining to the present invention constructed in the manner described above has excellent electrolyte solution retention because the surface of the chemical resistant fibers [sic] is coated with a terpolymer resin or polymer alloy with excellent chemical resistance. The affinity with the alkali-resistant fibers results in pronounced interactive bonding force, and there is little separation or shedding during the process of manufacturing the nonwoven fabric or during long-term charge and discharge cycles. It has stable liquid retention capacity over long periods of time, it has exceptional cycle life, and it has far greater cell life than in the past.

4. Brief Description of the Figures

Figure 1 is a schematic of the core-sheath type of composite fiber used in Practical Example 1. Figure 2 is an enlargement of the main parts of the alkaline cell separator, depicting an embodiment of the present invention. Figure 3 is a graph showing the relation between the retention of discharge capacity and the repetition of charging and discharging (cycles) of cells incorporating the separators obtained in Practical Examples 1 and 2 and in Comparative Example 1.

1: polypropylene resin; 2: ethylene-propylene-vinyl alcohol terpolymer resin; 3: polymer alloy; 4: polypropylene resin.

Figure 1

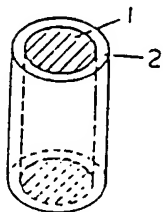


Figure 2

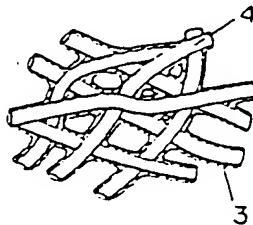
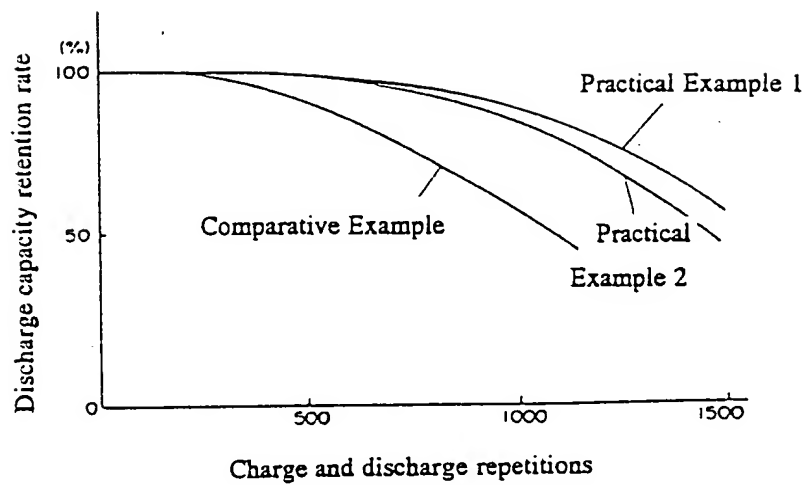


Figure 3



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SPECIFICATION

1. Title of the Invention

Alkaline Cell Separator

2. Claims

1. An alkaline cell separator, characterized by the fact that it is obtained when part or all of the surface of an alkali-resistant fiber comprising a nonwoven fiber sheet is coated with a hydrophilic ethylene-propylene-vinyl alcohol terpolymer resin or a polymer alloy consisting of an ethylene-propylene copolymer resin and an ethylene-vinyl alcohol copolymer resin.

2. An alkaline cell separator as defined in Claim 1, wherein the alkali-resistant fiber is a polyolefin-based fiber, and the coating of the hydrophilic resin given to the alkali-resistant fiber is effected by impregnation, coating, or a print process.

3. An alkaline cell separator as defined in Claim 1 or 2, wherein the alkali-resistant fiber comprising the separator forms a core-sheath composite structure with the hydrophilic ethylene-propylene-vinyl alcohol terpolymer resin, or the polymer alloy consisting of an ethylene-propylene copolymer resin and ethylene-vinyl alcohol copolymer resin, which is used to coat said fiber.

4. An alkaline cell separator as defined in Claim 1, wherein the hydrophilic ethylene-propylene-vinyl alcohol terpolymer resin, or the polymer alloy consisting of an ethylene-propylene copolymer resin and ethylene-vinyl alcohol copolymer resin, which is used to coat the fiber has a foamed or porous structure.

3. Detailed Description of the Invention

Field of Industrial Utilization

The present invention relates to a separator for secondary alkaline cells involving the use of an alkali electrolyte solution, such as nickel-cadmium cells.

Prior Art and Problems Therein

Nonwoven fabrics obtained with the use of nylon fibers such as nylon 6 and nylon 66 have often been used in the past as alkaline cell separators. Separators involving the use of nylon fibers have excellent hydrophilicity and thus have good affinity with electrolyte solutions, allowing high capacity cells with excellent retention performance (liquid retention properties) to be consistently obtained.

Nylon fibers have poor alkali-resistance, however, and alkaline cells involving their use as separators suffer from drawbacks in that trickle charge and discharge or the like employed in high temperature environments with the use of long-term cycles or the like result in lower strength as the fiber deteriorates, a lower discharge capacity due to the production of decomposition gas, and a shorter cycle life.

Because, on the other hand, polyolefin-based fibers such as polypropylene and polyethylene have excellent chemical resistance, the fibers have good alkali-resistance and little deterioration even with the use of long-term cycles, but they are extremely hydrophobic and have poor affinity with the electrolyte solution, thus suffering from major drawbacks in that the electrolyte solution retention properties are poor, and a high capacity cell cannot be obtained.

Methods proposed in the past to remedy such problems include the method in which treatment is undertaken using a hydrophilic surfactant, the method in which ruggedness is provided by foaming the fiber surface or the like so as to expand the surface area, and the method in which the fiber surface is activated by a plasma treatment or the like to improve the affinity with the electrolyte solution. Separators that have been treated with a surfactant, however, suffer from problems in that the active agent is freed and desorbed with the use of long-term cycles, leading to a rapid decline in the cell discharge capacity and a shorter life. Foaming treatment of the fiber surface and fibers treated with plasma to improve the hydrophilicity suffer from drawbacks in that the polyolefin-based material itself is considerably hydrophobic, making hydrophilicization difficult, and a consistent product cannot be continuously obtained.

Means Used to Solve the Above-Mentioned Problems

The present invention, which was undertaken so as to remedy the aforementioned drawbacks, is intended to offer a cell separator consisting principally of a highly hydrophobic alkali-resistant fiber, wherein said alkaline cell separator has good affinity with the alkaline electrolyte solution, has an excellent retention capacity, has stable charge and discharge characteristics over long periods of time, and thus has an extremely long cycle life.

Specifically, the present invention is intended to offer an alkaline cell separator, characterized by the fact that it is obtained when part or all of the surface of an alkali-resistant fiber is coated with a hydrophilic ethylene-propylene-vinyl alcohol terpolymer resin or a polymer alloy obtained by the polymer blending of an ethylene-propylene copolymer resin and an ethylene-vinyl alcohol copolymer resin.

The physical properties of ethylene-propylene-vinyl alcohol terpolymer resins (hereinafter abbreviated as terpolymer resin) or polymer alloys obtained by the polymer blending of an ethylene-propylene copolymer resin and an ethylene-vinyl alcohol copolymer resin (hereinafter abbreviated as polymer alloy) were noted, and the present invention was obtained upon the discovery that said terpolymer resins or polymer alloys have excellent chemical resistance, hydrophilicity, and spinning properties when composite fibers are fashioned.

The chemical resistant fiber in the present invention refers to a polyolefin-based fiber such as polypropylene or polyethylene, which may be used alone or mixed as needed in the form of a composite fiber such as a core-sheath structure.

No particular restrictions are imposed on the monomer composition ratio in the terpolymer resin or polymer alloy in the present invention, but an ethylene content of 10 to 40 mol %, a propylene content of 10 to 40 mol %, and a vinyl alcohol content of 40 to 80 mol % are preferred in consideration of the chemical stability, thermal stability, chemical resistance, hydrophilicity, spinning properties, mechanical stability, and the like of the resin that is obtained. Such a copolymer ratio and blend ratio result in a resin with suitable hydrophilicity as well as chemical and mechanical stability.

Polymer alloys and terpolymer resins with less than a 10% molar ratio each of ethylene and propylene suffer from problems in terms of spinning properties during composite spinning (such as core-sheath type), frequently resulting in yarn breakage, partial separation, or other such troubles, and even when [a coating] is applied by impregnation, coating, a printing process, or the like, there is poor adhesion with the polyolefin-based yarn and poor durability.

A polyvinyl alcohol molar ratio of less than 40% is undesirable because of marked deterioration in the hydrophilicity, leading to a decline in the electrolyte solution retention capacity.

Examples of means for coating the alkali-resistant fiber with such a terpolymer resin or polymer alloy include methods in which the coating is provided on a nonwoven fabric in the form of a sheet by impregnation, coating, or a printing process. A core-sheath type of composite fiber in which the core consists of the alkali-resistant fiber and the sheath consists of the terpolymer resin or polymer alloy can be used. The hydrophilicity can also be improved by foaming the terpolymer resin or polymer alloy, by rendering them porous, or the like in fashioning the coating configuration.

Practical Examples

The present invention is described in further detail below with reference to practical examples.

Practical Example 1

100% 2 d \times 51 mm core-sheath type composite fiber (core/sheath weight ratio = 60/40) involving the use of an ethylene-propylene-vinyl alcohol terpolymer consisting of 20 mol % ethylene, 15 mol % propylene, and 65 mol % vinyl alcohol as the sheath component 2 and polypropylene 1 as the core component was used as the constituent fiber for the separator, as shown in Figure 1. A composite yarn with good yarn quality could be manufactured without any troubles such as yarn breakage or partial separation when the fiber was spun.

A web in the form of a matte obtained by uniformly splitting* said fiber was heated and pressure bonded by a calender roll process to obtain Separator A pertaining to the present invention (weight: 85 g/m²; thickness: 0.20 mm).

Practical Example 2

30 parts ethylene-propylene copolymer resin (consisting of 40 mol % ethylene and 60 mol % propylene) and 70 parts ethylene-vinyl alcohol (consisting of 20 mol % ethylene and 80 mol % vinyl alcohol) were uniformly dissolved in 900 parts isopropyl alcohol to prepare a solution with 10% solids.

This solution was then used to impregnate a polypropylene nonwoven cloth (weight: 70 g/m²), which was then dried and adjusted to obtain Separator B pertaining to the present invention (weight: 84 g/m²; thickness: 0.20 mm).

Figure 2 is an enlargement of the separator obtained in Practical Example 2 above. The polymer alloy 3 constituting the separator had excellent wetting properties with the polypropylene fiber 4, and the fiber intersections and fiber surfaces were virtually uniformly coated.

Comparative Example

A mixed web consisting of 70% 15 d × 38 mm nylon 6 and 30% 2 d × 38 mm core-sheath composite nylon (consisting of a nylon 6 core and a nylon 6-10-12 sheath copolymer) was contact bonded and adjusted to a prescribed thickness by a calender roll process, and the nonwoven cloth (weight: 85 g/m²; thickness: 0.20 mm) thus obtained was used as a comparative separator.

The physical properties of the products obtained in Practical Examples 1 and 2 and in Comparative Example 1 are shown in the following table.

* Translator's note: Here and elsewhere, an asterisk denotes a term that is uncertain owing to poor copy legibility.

	Practical Ex. 1	Practical Ex. 2	Comparative Ex. 1
Weight (g/m ²)	85	84	85
Thickness (mm)	0.20	0.20	0.20
Liquid retention (%) *1	403	385	397
Absorption rate (mm) *2	65	73	68
Alkali resistance (%) *3	0.7	0.9	3.5

*1: The separator material was immersed in a caustic potash solution (specific gravity 1.30), hung and dried for 10 minutes, and rinsed with water; the solution absorption rate was then determined.

*2: One end of a separator in the form of a strip was immersed in a caustic potash solution with a specific gravity of 1.30, and the height of the absorption was measured after vertically standing for 30 minutes.

*3: The rate of decrease in weight was measured during one month of immersion at 80°C in a caustic potash solution with a specific gravity of 1.30.

The test results for cell performance using the separators obtained in Practical Examples 1 and 2 and in Comparative Example 1 are shown in Figure 3.

The figure shows the rate at which the discharge capacity was maintained when the aforementioned separators were incorporated into cells with a capacity of 1200 mA/hr and repeatedly charged and discharged. The horizontal axis shows the number of times the cells were charged and discharged (cycles), and the vertical axis shows the rate at which the discharge capacity was maintained.

The test conditions involved a temperature of 20°C, charge conditions of 400 mA × 4 hr, and discharge conditions of 1 Ω constant resistance discharge × 2 hr. It is apparent from Figure 3 that cells involving the use of the separator pertaining to the present invention are characterized by little loss of discharge capacity, despite repeated charge and discharge, and favorably withstood long-term use.